BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED

Technical Specification for Star-1 Rated (EEL- 1), 11/0.433kV, 3Phase, 50Cycle, Aluminium Wound, CRGO Core Distribution Transformer of rating 25/63/100kVA

1. SCOPE:

This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing at works before supply of 3 phase, 50 Hz, core type, oil immersed self cooled Distribution Transformer confirming to Star-1 (old 4Star) Rated of IS:1180(Part1):2014 and IS:2026 of 1977as amended from time to time for outdoor use.

It is not the intent to specify completely herein all the details of the design and construction of equipment. However the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of suppliers supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The transformer and accessories shall be designed to facilitate operation, inspection, manufacture and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.

The transformers shall be manufactured strictly as per specification, without any deviations.

2. STANDARDS

The materials shall conform in all respects to the relevant Indian/International Standards, with latest amendments thereof unless other wise specified herein. Some of them are listed below:

Indian Standard	Title	International and internationally recognised standards
IS:2026/1977 (Parts 1 to 5)	Specification for Power Transformers	IEC:76
IS:1180 (Part 1) :2014	Outdoor distribution transformer up to and including 2500kVA	

IS:12444	Specification for copper rod	ASTM B-49
IS:335/1993	Specification for transformer Oil	BS148, D-1473, D1533-1934, IEC Pub 296
IS:5/1944	Specification for colours for ready mixes colours	
IS:104/1979	Ready mixed paint, brushing zinc chromate, priming	
IS:2099/1986	Specification for high voltage porcelain bushing	
IS:649/1997	Testing for steel sheets and strips and magnetic circuits.	
IS:4257	Dimensions for clamping arrangements for bushings.	
IS:7421	Specification for low Voltage bushings	
IS:3347 (Parts I to IV)	Specification for Outdoor Bushings	DIN 42531 to33
IS:5484	Specification for Al Wire rods	ASTM B:233
IS:9335	Specification for Insulating Kraft Paper	IEC 554
IS:1576	Specification for Insulating Press board.	IEC 641
IS:6600	Guide for loading of oil Immersed Transformers.	IEC76
IS:2362	Determination of water content in oil for porcelain bushing of transformer, by Karl fischer method-test method.	
IS:6162/1971 (Parts I & II)	Paper covered aluminium conductor.	
IS: 6160/1971	Rectangular electrical conductor for electrical machines.	
IS: 5561/1970	Electrical power connector.	
IS:6103/1971	Testing of specific resistance of electrical insulating liquids.	
IS:6262/1971	Method of test for power factor and dielectric constant of electrical insulating liquids.	
IS:6792/1992	Determination of electrical strength of insulating oil.	
IS:10028/1985 (Parts I to III)	Insulating and maintenance of transformers.	
IS: 10028:	Selection, installation & maintenance of transformers	
IS: 3401	Silica gel	

	REC specification No.2	
IS 3024	Grain oriented electrical steel sheets and strips	
IS 191	Copper	
IS 1897	Copper strip for electrical purpose,	
IS 7404(Part1)	paper covered copper conductors	
IS 13730	Specification for winding wires	

Materials conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above, would also be acceptable. In case the suppliers who wish to offer material conforming to other standards, the supplier shall clearly bring out the salient points of difference between the standards adopted and the specific standards in relevant schedule. Five copies of such standards with authentic English translations shall be furnished along with the offer.

3. SERVICE CONDITIONS:

The materials used to manufacture of Distribution Transformer to be supplied against this specification shall be suitable for outdoor satisfactory continuous operation under the following climatic conditions.

a. Ambient Air Temperature - 5°C to 50°C
b. Relative Humidity - 0 to 100%
c. Altitude - A height above sea level not exceeding 1000m (3300ft).

4. SYSTEM DETAILS:

The transformers shall be suitable for outdoor installation with 3Phase, 50 Hz, 11kV System in which the neutral is effectively earthed and the same shall be suitable for service under fluctuations in supply voltage up to 12.5% permissible under Indian Electricity Rules and the frequency variation of -5% and +2% (47.5Hz to 51.0Hz).

5. The transformers shall conform to the following specific parameter:

Sl No.	Item	11kv Distribution transformers
1.	System voltages (max).	12kV
2.	Rated voltages HV	11kV
3.	Rated voltages (No Load)LV	433-250V
5.	Rated Frequency	50Hz
6.	Phases	Three
7.	Connection HV	Delta
8.	Connection LV	Star (Neutral brought out)
9.	Vector group	Dyn-11
10.	Type of cooling	ONAN as per IS 2026
11.	% of impedance at 75 °C	4.5%
12.	Fault level of the system	750MVA

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed distribution transformer shall be as below (NEMA Standards)

kVA rating	Audible sound levels (decibels)
0-50	48
51-100	51

6. TECHNICAL REQUIREMENTS:

Core Material: CRGO Material

The core shall be high grade stack type of high grade cold rolled grain oriented annealed steel lamination having low loss and good grain proper ties, coated with hot oil proof insulation, bolted together and to the framed to prevent vibration or noise. The core shall be stress relived by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer.

The supplier should offer the core for inspection and approval by the purchaser during manufacturing stage.

The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The supplier shall furnish necessary design data in support of this situation.

No-load current shall not exceed 3% of full load current and will be measured by energising the transformer at 433 volts, 50Hz on the secondary. Increase of voltage of 433 volts by 12.5% shall not increase the no-load current by 6% (maximum) full load current.

7. WINDINGS:

The primary winding shall be connected in delta and the secondary winding in star (vector symbol Dyn11) so as to produce, a positive phase displacement of 30 degrees from the primary to the secondary vectors of the same phase. The neutral of the secondary winding shall be brought out to a separate insulated terminal.

HV and LV windings shall be wound from Double Paper covered aluminium conductor.

LV windings shall be such that neutral formation will be at top.

Inter layer insulation shall be Nomex/Epoxy dotted Kraft Paper.
Proper bonding of inter layer insulation with the conductor shall be ensured.
Test for bonding strength shall be conducted.

Dimensions of winding coils are very critical. Dimensional tolerances for windings coils shall be with in limits as specified in Guaranteed Technical Particulars.

Current density for HV and LV winding should not be more than 1.6 Ampere per sq mm for aluminium conductor.

The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor.

8. Oil:

The New insulating oil shall be of Uninhibited (U) Type-II, comply with the requirements of IS:335/2018 or BS:148. Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than 2.5x 10 12 ohm-cm at 27°C when tested as per IS 6103.

Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.

The oil shall be filled under vacuum.

The transformer shall be supplied complete with first filling of oil and tile same shall comply with IS: 335/2018 with latest revisions thereof and ageing characteristics specified.

a) NEW OIL:

Sl. No.	Characteristics	Unit	Guaranteed Data	
			Min	Max
1	Appearance		Clear free from sediment and suspended matter	
2	Density at 20° C	g/ml		0.895
3	Kinematic Viscosity at 40° C	mm²/sec		15
	at - 0° C			1800
4	Flash Point, PMCC	° C	135	
5	Pour Point	° C		-10
6	Inter Facial Tension at 25°C	mN/m	No General Requirement (40 min)	
7	Acidity	mq KOH/g		0.01
8	Water Content, Bulk/Drum, IBC	mg/kg		30/40
9	Breakdown Voltage			
	As delivered/ After Treatment	kV	30/70	

10	Dielectric Dissipation Factor (Tan δ) at 90°C & 40 to 60 Hz			0.005
11	Corrosive Sulphur Silver Strip, 100°C, Hrs		Not Corrosive	
12	Potentially Corrosive Sulphur		Not Corrosive	
13	DBDS	mg/Kg	Not Detectable (<5 mg/kg)	
14	Total Sulphur Content	%	No General Requirement	
15	Inhibitors according to IS 13631/IEC 60666		(U) Uninhibited Oil Not Detectable (<0.01%)	
16	Metal Passivator additives according to IS 13631/ IEC 60666	mg/kg	Not Detectable (<5 mg/kg)	
17	Other Additives		Does Not contain any additives	
18	Oxidation Stability at 120°C, 164 Hrs			
	Total Acidity	mg KOH/g		1.2
	Sludge	%		0.8
	DDF at 90 °C			0.500
19	Gassing Tendency	µL/min	No General Requirement	
20	PCA Content	%		3
21	PCB Content	mg/kg	Not Detectable (< 2mg/kg)	
22	2- Furfural and related compounds content	mg/kg	Not Detectable (< 0.05 mg/kg) for each individual compound	
23	ECT		No General Requirement	
24	Particle Content		No General Requirement	

b). The important characteristics of the transformer oil after it is filled in the transformer (with in 3 months of filling) shall be as follows.

All tests to verify the characteristics mentioned as above shall be carried out in accordance with IS: 1866/2017.

9. PERCENTAGE IMPENDENCE:

The value of impedance of transformer at 75°C shall be 4.5% and tolerance shall be in accordance with IS: 1180(part I) 2014.

10. TEMPERRATURE RISE:

The temperature rises over ambient shall not exceed the limits given below:

a. Top oil temperature rise measure by thermometer : 35°C
b. Winding temp rise measured by resistance method: 40°C

Bids not meeting the above limits of temperature rise will not accepted

The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Supplier shall submit the calculation sheet in this regard.

11. NO LOAD VOLTAGE RATIO:

The No Load Voltage ratio shall be 11000/433-240V, for all capacities of distribution transformers at normal tap.

12. INSULATION LEVELS:

Sl No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage (kV)
1.	0.433	-	3
2.	11	75	28

13. DESIGN & CONSTRUCTION:

CORE:

a) The core shall be of high grade CRGO steel sheet of M3 or superior to that having low loss and non ageing grain oriented, coated with hot oil proof insulation, bolted together to the frames firmly to prevent vibration or noise. All core clamping bolts shall be effectively insulated.

The complete design of core must ensure permanency of the core losses with continuous working of the transformers. The value of the flux density shall not be more than 1.7 tesla at 50 HZ.

The maximum flux density in any part of the core and yoke at rated voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla

The construction of core, internal clearances minimum effective area of cross section, minimum Nos. of core steps etc., shall be strictly as per the drawings enclosed.

b) The transformers core shall not be saturated for any value of V/F ratio to the extent of 112.5% of the rated value of V/F ratio i.e., 11kV/50Hz. (Due to combined effect of voltage and frequency) upto 12.5% without injurious heating at full load conditions the core shall not be saturated.

The Supplier shall furnish necessary design data in support of this condition

c) The maximum thickness of core laminations shall not exceed 0.23mm Further the lamination sheets used for top yoke, bottom yoke etc., shall be of single piece.

d) No load current, shall be measured by energizing the transformers at 433 volts 50 C/S on the secondary for distribution transformers. Increase of voltage by 10% shall not increase the no load current disproportionately high. Test for magnetic balance by connecting the LV phase by phase to rated phase voltage and measurement of an, bn, cn, voltage shall be carried out. The no load current, shall not exceed 3% in respect of 100KVA and below distribution transformers, at rated voltage and frequency.

The minimum
(1) Effective core area
(2) Number of core steps
(3) Internal clearance

Shall be furnished by the supplier along with the bid offer.
Minimum effective cross sectional area of the core to be provided are as follows:

1) 25KVA - 41.18 sq.cm.
2) 63KVA - 84.60 sq.cm.
3) 100KVA - 105.65sq.cm.

Note: If the manufacturer uses the better quality CRGO steel for the core the manufacturer has to furnish the area of cross section of the core along with the design details.

e) The unbalance current in the neutral shall not be more than 2% of the rated current.

14. CORE CLAMPING:

1) M.S.Channel 75 x 40mm for 100 KVA and below transformers on top and bottom shall be used for clamping the core.

2) 2 Nos. of 12mm high tensile vertical bolts in parallel in each side shall be provided. The size of the Bolts to be provided in parallel are as follows:

a) 25, 63, 100KVA - 2 Nos. of 12mm High Tensile Bolts

3) Channel on LV side to be reinforced at equidistance if hole cutting is done for LT lead so as to avoid bending of channel.

M.S. Channels are to be painted by varnish and corrosion oil resistant paint before use.

5) Flat or cut channel shall not be used.

6) Core mounting is to be done with ISF 50x10 for Transformers up to and including 100KVA transformer.

7) Clamping arrangement should be strong enough to withstand mechanical forces. The mechanical strength shall be proven by short circuit test.

TIE BOLTS:

Four horizontal tie rods (HT steel) of 12mm dia for transformers up to l00KVA shall be used. Rods to be effectively insulated with kraft paper tube of thickness I.5mm.

i) All top and bottom Yoke nuts bolts and tie rods shall be painted with oil and corrosion resistant paint before use.
ii) Channel - (top yoke) on LV side to be reinforced at equidistance if hole cutting is done to avoid bending of channel.
iii) The flat provided at the core shall be as per the drawings enclosed and shall not be cut through the length.
iv) Tie rods shall be effectively earthed.
v) Drawing of the building of the core shall be got approved before start of the work

15. WINDINGS:

a) **Material-** Double layer paper covered Aluminium conductor shall be used.
b) The nominal HV winding cross section shall be as follows:

SL. No.	Rating	
1	25KVA	0.9503 Sq.mm.
2	63KVA	2.835 Sq.mm.
3	100KVA	4.5239 Sq.mm.

c) The nominal LV winding cross section shall be as follows:

SL. No.	Rating	
1	25KVA	40.3 Sq.mm.
2	63KVA	90.44 Sq.mm.
3	100KVA	159.32 Sq.mm.

d) LV winding shall be in even layers

e) The neutral formation shall be at top

Note: If any other than the above cross section of HV/LV windings, details shall be furnished.

16. LOSSES AND IMPEDANCE:

The supplier shall guarantee individually the no-load losses and loss without any positive tolerance. The supplier shall also guarantee the total losses at 50% and 100% load condition (at rated voltage and frequency and at 75°C).

The maximum allowable losses & impedance at rated voltage and rated frequency permitted at 75°C for 11/0.433kV transformers as per IS 1180(Part-1):2014 Amendment No. No.4 March 2021 Table-3 EEL-1 is as below:

Voltage ratio:	Ratings (kVA) EEL-1	Max Losses at 50% loading (watts)	Max Losses at 100% loading (watts)	Impedance % (subject to tolerance as per IS:2026)
11kV/433-250V	25	190	635	4.5
	63	340	1140	
	100	475	1650	

17. TOLERANCE:

No positive tolerance shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

18. PENALTY FOR NON PERFORMANCE:

During testing at supplier's works, if it is found that the actual measured losses are more than the values quoted by the supplier, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.

Purchaser shall reject the entire lot during the test at suppliers works, if the temperature rise exceeds the specified values.

Purchaser shall reject any transformer during the test at suppliers works, if the impedance values differ from the guaranteed values including tolerance.

19. INSULATION, INSULATION MATERIAL& CLERANCES:

Electrical grade insulation epoxy dotted Kraft Paper/Nomex and pressboard of standard make or any make other superior material subject to approval of the BESCOM shall be used.

All spacers, axial wedges/runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC641-3-2. In case of cross- over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges/runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations.

a) blocks at top and bottom of each coil assembly shall be provided. There must be atleast 4 blocks per phase/coil of each of thickness of 5mm. Core wrapper shall be of minimum of 1mm thick.

The channel at phase barrier board shall be of 2mm thick press board. The tie rod insulation craft paper shall be of thickness 1mm. Between HV and LV windings addition press Board cylinder of at least 2mm in addition to spacers shall also be provided.

b) No. of vertical/axial wedges up to 100 KVA minimum 18 Nos., shall be provided depending upon the capacity of transformers between LV and HV windings and equispaced around LV. The wedge shall be minimum 6.5mm thick wide.

c) The inter layer insulation shall be provided between HV windings layers depending on the design. The details shall be furnished.

d) The Neutral connection of LT winding shall be formed using aluminium strip of same size as that of 'S' type link of size 25x3mm. Aluminium strip for 25/63/100 KVA transformers.

e) The Delta formation of HV winding shall be made using copper jumper leads of size 1.6mm dia. for 25/63/100KVA, 2.65MM transformers. The leads shall be enclosed in Kraft insulated paper tube.

f) Double paper covering shall be used for winding insulation both for HV & LV windings. Either performed corrugated cylindrical boards or cylindrical compressed boards with spacers shall be provided between HV & LV windings. Press board of type - D IS: 1576 to be used for top and bottom yoke insulation. The electrical grade insulating paper shall be of Triveni/Ballarpur or equivalent make subject to approval of BESCOM. Press boards used shall be of M/s. Senapathi whitely or M/s. Raman Boards or equivalent make subject to approval of BESCOM.

g) Radial clearance of LV coil to core (bare conductor) shall not be less than.

1. for 25 KVA - 3.5MM
2. for 63 KVA - 3.5MM
3. for 100KVA - 4.0MM

h) Radial clearance between HV and LV coils shall not be less than 10mm for all capacities.

i) Phase to phase clearance between HV coils shall not be less than 15mm. A minimum of 2 Nos. of 1mm press board shall be used to cover the tie rods.

j) The minimum electrical clearance between the winding and body of the tank (between inside surface of the tank and outside edge of the winding) shall not be less than 30mm.

k) End insulation to earth shall not be less than 25mm.

l) HV & LV coils single coil multi layer winding shall be used for all capacities of transformers.

m) Tap lead shall be insulated with 1.5 mm thick paper insulation. Inspection of windings prior to tankings shall be done. Manufacturing drawing for the transformer showing various clearance shall have to be approved by the BESCOM.

20. TANK:

The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.

All joints of tank and fittings shall be oil tight and no bulging should occur during service.

In side of tank shall be painted with varnished/hot oil resistant paint.

Top cover of the tank shall be slightly slopping to drain rain water.

The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.

The rating and serial no's. of the transformer shall be embossed/punched on the tank of transformer/ on transformer name plate fitting sheet of the transformer. In addition to name plate details of transformer fitted to the transformer tank.

Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the BESCOM.

The transformer tank shall be of robust construction only in rectangular/ Octagonal shape and shall be built up of electrically tested welded mild steel top and bottom plates thickness of 5.00 mm and 3.15 mm for the side wall thickness.

Suitable reinforcement by welded angle shall be provided on all the outside walls on the edge of the tank. The permanent deflection shall not be more than 5mm up to 750mm length and 6mm up to 1250mm length and 8mm up to 1750mm length when transformer tank without oil is subjected to Air pressure test as per IS:1180.

Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/sq.cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS:1747.

Pressure and vacuum requirements:

The transformer plain tank shall be capable of withstanding a pressure of 80kPa and a vacuum of 250mm of Mercury without any deformation.

Radiators: The radiators can be tube type or fin type or pressed steel type to achieve the desired cooling to limit the specified temperature rise.

1) **Lifting lugs:**
   2 Nos, for 25KVA, 63KVA and 100KVA and 4 Nos. for 250KVA and 500KVA transformers of welded heavy duty lifting lugs of M.S. Plate 8mm thick suitably reinforced by vertical supporting flat welded edgewise below the lug on the side wall shall be provided.

2) **Top Cover Fixing Bolts:**

   - Gaskets shall be made of Synthetic rubber or synthetic rubberised cork resistant to hot transformer oil confirming to Is 11149/Type C as per IS-4253 Part-II shall be placed between top cover plate and tank.

- All bolts/nuts/washers exposed to atmosphere shall be as follows
  a) Size 12mm or below – Stainless steel.
  b) Above 12mm- steel with suitable finish like electro galvanized passivation or hot dip galvanized.

- GI bolts and nuts shall be size 12mm x 40mm with one plain and one spring washer suitably apart (100mm) to press the cover.

3) Tolerance on tank dimensions shall be limited to -5% to + 10%.

21. HEAT DISSIPATION:

a) Heat dissipation by tank walls excluding top and bottom should be 500 watts / Sq. mtr.

b) Heat dissipation by radiator 1.25mm thick shall be considered for heat dissipation calculation. The tenderer shall submit the calculation sheet along with No. of radiators to be provided and type of fixing radiators to the transformer tank.

c) The guaranteed temperature rise of oil and winding shall be found by conducting temperature rise test in presence of the representative of the BESCOM.

22. TOTAL OIL VOLUME (Approx):

Sl. No.	Rating	Oil in Ltrs. (inclusive for oil absorbed in core coil assembly)
1	25KVA	96
2	63KVA	170
3	100KVA	230

NOTE: If the specified amount oil is insufficient, additional quantity may be furnished in the offer and absorption of oil in the core and winding assembly is more than permissible value first filling oil volume should be increased accordingly detailed calculation of absorption shall be submitted.

23. CONSERVATOR:

Conservators shall be provided on transformers of rating 25KVA, 63KVA, 100KVA,
When a conservator is fitted, the oil gauge and the plain or dehydrating breathing device shall be fixed to the conservator which shall also be provided with a drain plug and a filling hole (1¼ nominal size thread) with cover. In addition, the cover of the main tank shall be provided with an air release plug to enable air trapped within to be released. Unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.

a) Prismatic oil level indicator shall be provided on the side which will be fully covered detachable flange with single neoprene gasket and tightened with M.S. bolts and nuts.

b) The inside diameter of the pipe connecting the conservator to the main tank shall be with in 20 to 50 mm and it should project in to the conservator in such a way that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of Impurities. The minimum oil level (corresponding to - 5° C) should be above sump level.

c) The pipe from conservator tank connecting to main tank shall be sloping so that the oil falling from the pipe shall not fall directly on the active parts and shall fall on the side walls only.

d) The conservator shall be provided (except for 25KVA) with the drain plug and filling hole with cover. In addition, the cover of the main tank shall be provided with an air release plug (except for 25KVA).

e) Conservator pipes fixing conservator to the top plate of the transformer should be on either side of metal pocket provided for mounting LT bushings with minimum electrical clearance of 110mm between phases and also earth.

24. BREATHERS :

Breather joints shall be of bolted type. It shall have die cast Aluminium body and inside container for Silica gel shall be of tin. Makes of Breathers shall be subject to BESCOM approval.
The volume of the breather shall be

a) 250 grams of silica gel breather shall be provided for 25 KVA, 63 KVA and 100 KVA transformers.

The breather shall have an inspection window to view the condition of the silica gel.

25. TERMINALS:

Brass rods 12mm dia for HT and LT for 25KVA, 63KVA and 100KVA Transformers may be provided.

a) HT/LT Bimetallic connectors shall be provided to 25KVA, 63KVA and 100KVA transformers.

b) The metallic connector shall be L type for LT bushing of distribution transformer of capacity of 100.

c) The HV and LV windings conductor shall not be terminated to the bushing rod directly.

d) The HV winding shall be linked through a terminal lug and copper jumper lead of size 1.6mm dia for 25/63/100KVA transformers. The leads shall be enclosed in kraft paper tube.

e) The LV winding shall be terminated using inverted 'S' type link of size 25x3mm Aluminium strip for 25/63/100KVA transformers.

1) All the leads / links shall be immersed in oil.

2) All the leads/links shall be taken neatly strapped on an insulated press Board/wooden Bus Bar.

26. BUSHINGS:

I. For 11KV, 12KV Bushings (confirming to IS: 2099/1986) with single gap arcing horns shall be used and for 433 volts, 1.1KV terminal Bushings confirming to IS: 7421/1974shall be used. Alternatively, the low voltage side may be suitable for adoption of PVC/XLPE cables of suitable size. Bushings of the same voltage class shall be interchangeable. The dimensions of Bushings shall be as per IS-3347 and these Bushings shall be mounted on side of the tank or on the top cover. The bushings mounted on the side shall not have an inclination of more than 30 degrees from the vertical as per CBIP manual and IS-2099. Only sheet metal pocket shall be provided for mounting HV bushings alternately the same can be mounted on pipes. Creepage distance shall not be less than 25mm/KV as per IS: 2099-1986.

II. **Brazing of all internal connections** – All jumpers from windings to bushing shall have a cross section larger than tail winding conductor. For copper, silver brazing alloy to be used. For aluminium, L&T aluminium brazing rods shall be used.

III. The minimum phase to phase and phase to earth external clearances for HV & LV Bushings shall be as follows: as per table 10 IS:1180(Part-1) :2014

	Minimum clearances	
	Phase to phase (in mm).	**Phase to earth**
HV Bushings	255	140
LV Bushings	75	40

The above 140 mm. clearance does not apply to arcing horn gap.

27. TANK BASE CHANNEL:

a) For 25, 63 & 100KVA Trans. ISMC 75 x 40mm. channel shall be used for base.

28. TERMINAL MARKING PLATE AND RATING PLATES:

The transformer shall be provided with a Anodized aluminium/stainless steel plate securely fixed on the outer body showing the relative physical position of the terminal and their markings. This shall be in accordance with IS: 1180(Part1):2014. The transformers shall be provided with rating plate furnishing the information as specified in 1180(Part1):2014.

The month and year of delivery shall be indicated on the rating plate. The rating plate shall be embossed / engraved type but not painted. The serial No. of transformer shall follow the code Nos. as detailed in clause 56.

The Standard mark as given in column 1 of the First schedule of the licence shall be applied clearly and indelibly by stencilling/screen or ink jet printing/embossing/etching/engraving on the rating plate.

In addition, the BIS Certification Mark Licence No and reference to BIS website shall be clearly and indelibly marked on the rating plate.

29. SURFACE PREPARATION AND PAINTING:

General

All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

All primers shall be well marked into the surface, particularly in arrears where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is not possible, conventional spray be used with prior approval of BESCOM.

30. CLEANING AND SURFACE PREPARATION:

After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

Steel surface shall be prepared by shot blast cleaning (IS: 9954) to grade Sq. 2.5of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS: 3618).

Chipping, scrapping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical. Manufacturer shall clearly explain such areas in his technical offer.

31. PROTECTIVE COATING:

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

32. PAINT MATERIAL:

Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site;

For inside surface, Heat resistant paint (Hot oil proof).

For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel/Polyurethene base paint. These paints can be either air drying or stoving.

33. PAINTING PROCEDURE:

All prepared steel surfaces should be primed before visible re-rusting occurs or within 4hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.

Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%.

34. DAMAGED PAINTWORK:

Any damaged occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.

35. DRY FILM THICKNESS:

To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats may or may not be the same colour.

Each coat of paint shall be allowed to harden before the next is applied as per manufacturers' recommendation.

Particular attention must be paid to full film thickness at the edges.

The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl No.	Paint Type	Area to be painted	No. of coats	Total dry film thickness (min) (microns)
1.	Thermo setting powder paint	Inside outside	01 01	30 60
2.	Liquid Paint a) Epoxy (primer) b) P U. Paint (Finish coat) c) Hot oil Paint/ Varnish	 Out side Outside Inside	 01 02 01	 30 25 each 35/10

36. TESTS FOR PAINTED SURFACE:

The painted surface shall be tested for paint thickness.

The supplier shall guarantee the painting performance requirements for a period of not less than 5 years.

37. FITTINGS:

The following standard fittings shall be provided:

i. Rating and terminal marking plates, non-detachable.
ii. Earthing terminals with lugs-2Nos.
iii. Lifting lugs for main tank and top cover - 2nos.
iv. Terminal connectors on the HV/LV bushings (For bare terminations only)
v. Thermometer pocket with cap - 1 No.
vi. Air release plug on main tank (except for 25kVA) device
vii. HV bushings - 3 Nos.

viii. LV bushings - 4Nos.
ix. Pulling lugs
x. Stiffener
xi. Radiators -No. and length may be mentioned (as per heat dissipation calculations.
xii. Arcing horns
xiii. Prismatic oil level gauge
xiv. Drain cum sampling valve (except for 25kVA)
xv. Oil filling hole having p. 1-1/4 "thread with plug and drain plug on the conservator.
xvi. Silicagel breather
xvii. Base channel 75x40mm for up to 100kVA
xviii. Pressure relief device or explosion vent.

38. FASTENERS:

All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.

Bolts or Studs shall not be less than 6mm in diameter except when used for small wiring terminals.

All nuts and pins shall be adequately locked.

All the bolts/nuts/washers exposed to atmosphere shall be of steel with suitable finish like electro galvanised with passivation or hot dip galvanized

39. TESTS:

All routine tests, special tests and acceptance tests shall be conducted on transformers of each capacity. The Transformers offered shall be fully type and tested as per IS 1180 Part1-2014 (Clause 21) and relevant parts of IS 2026 of the offered transformers at CPRI/ERDA/Accredited Govt. Labs recognised by BIS and the date of type test shall not be older than 5 years.

40. TYPE TEST TO BE CONDUCTED ON ONE UNIT

The following shall constitute the type tests as per IS-1180 (Part I):2014 and its amendments thereon.

The test basis for all characteristics other than insulation is the rated condition unless the test clause states otherwise. Where it is required, test results shall be corrected to a reference temperature of 75°C.

1. Lightning impulse Test – IS 2026:2009 (Part 3) and shall comply with clause 14 of IS (Chopped Wave Testing).
2. Temperature Rise Test – IS 2026(Part-2)

   NOTE: Maximum measured total loss (No load at rated excitation + load loss at minimum current tap converted to 75degC reference temperature) at 100% loading shall be supplied during temperature rise test.
3. Short Circuit withstand Test – IS 2026 (Part5)
4. Pressure Test – IS 1180(Part 1): 2014. Clause 21.5.

41. SPECIAL TESTS:

The following special test conducted on one unit of each capacity of transformer as per IS 1180 Clause (21.4) at CPRI/ERDA/Accredited Govt. Labs recognised by BIS. The reports shall not be older than 5 years and reports shall be furnished at the time of inspection.

a) Determination of sound levels IS 2026(Part 10).
b) No Load current at 112.5% voltage – IS 1180(Part1):2014.
c) Paint adhesion tests. The test is performed as per ASTM 03359 (Standard Test Methods for measuring adhesion by Tape test).
d) BDV & Moisture content of oil in the Transformer –IS 1866-2017.

42. Routine Tests: Routine test before and after short circuit test shall be as per IS 2026(Part1)

1) Measurement of winding resistance. – IS 2026(Part1)
2) Measurement of voltage ratio, polarity, phase sequence and Check of voltage vector relationship IS 2026(Part1)
3) Measurement of impedance voltage/short circuit impedance and load losses at 50% and 100% load - IS 2026(Part1)
4) Measurement of no load loss current- IS 2026(Part1)
5) Measurement insulation resistance. - IS 2026(Part1)
6) Induced over voltage withstand test. - IS 2026(Part3)
7) Separate source voltage withstand test.-IS 2026(Part3)
8) Neutral current measurement: The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current. IS 2026(Part1)
9) Oil samples (one sample per lot) to comply with IS: 1866. IS 2026(Part1)
10) Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.
11) Pressure and vacuum test for checking the deflection. IS 1180(Part1):2014
12) Oil Leakage Test – IS-1180(Part1): 2014.

One out of the every consignment of the transformers received at stores, above Routine Tests shall be conducted mandatorily (at Stores). In case of failure, all the transformers in that consignment shall be tested and transformers which pass the test shall be accepted.

43. TYPE AND ROUTINE TEST CERTIFICATES:

1. All the type and routine tests as stipulated in the relevant standards shall be carried out by the supplier in the presence of BESCOM representative.

2. It may also be noted that the purchaser reserves the right to conduct short circuit test and impulse voltage withstand test in accordance with the IS, afresh on each ordered rating, even if the transformers of the

same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the purchaser either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the supplier.

3. Immediately after finalization of tile programme of type/ acceptance/ routine testing, the supplier shall give fifteen days advance intimation to the BESCOM to enable to depute its representative for witnessing the tests. The routine test certificate shall be submitted along with tile inspection offer.

44. ACCEPTANCE TEST:

At least 10% transformers of the offered lot (minimum of one) shall be subjected to routine/acceptance test in presence of BESCOMs representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS: 1180 and IS: 2026.

Checking of weights, dimensions, fitting & accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings.

Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report

All the assembled/ finished transformers prior to despatch shall be subjected to routine tests as per IS: 1180. The supplier shall invariably furnish manufacturer's routine test certificate along with inspection call of the offered transformers for pre-despatch inspection. The inspection offers without furnishing of routine test certificates as per ISS of all the transformers offered for final inspection shall not be entertained, and any delay on this account shall be to firm's account.

The selected samples shall be subjected to the following acceptance tests at the manufacturer's works in accordance with the relevant ISS:

1. Insulation resistance
2. Separate source voltage withstand test
3. Induced over voltage withstand test
4. Measurement of windings resistance cold (at or near the test bed temperature)
5. Measurement of Voltage ratio and check of voltage vector relationship
6. Measurement of Impedance voltage and load losses at rated current and normal frequency.
7. Measurement of total losses at rated voltage and rated frequency (at 50% & 100% loading).

8. Measurement of No load losses & current at 100 % and 112.5% of rated voltage and normal frequency.
9. Checking of rating and terminal marking plate.
10. Checking of weights, dimensions, fittings and accessories, tank sheet thickness, oil quantity, material, finish, paint thickness and workmanship as per purchase order and contract drawings.
11. Physical verification of core – coil dimension, internal clearances, provisions of required oil ducts in the HV and LV winding, conductor sizes, individual weights of HV and LV winding core laminations etc., with reference to contract drawings and type test report(s) by dismantling selected unit(s). The physical verification shall be conducted on units equivalent to one unit per 50 Nos. or part thereof of offered quantity randomly selected from the offered lot. The dismantled unit(s) after re-assembly shall be accepted by the purchaser after routine testing in presence of his representative. During final inspection, sheet thickness shall also be measured of the transformer opened for physical verification. The instrument for measurement of sheet thickness will be provided by the supplier.
12. Oil dielectric strength (break down voltage) test shall be carried out on the transformers opened for physical verification and average value shall be calculated.
13. Checking of manufacturer's test certificates and invoices for major raw materials shall be done and copies thereof duly signed by firm's representatives and inspecting officers shall be enclosed with the inspection report.

    Invoices of CRGO material shall be provided by the supplier to the inspecting officer at the time of inspection and same shall be verified by the inspecting officer.

Following tests shall also be carried out at manufacturer's works on one complete unit of Transformers unit:

a. Air pressure test on empty tank of transformer opened for physical verification test. (See note below)
b. Measurement of unbalance current.
c. Magnetic Balance Test (See note below)
d. Oil Leakage Test (See note below)

Fifteen days clear notice shall be arranged for pre-despatch inspection by BESCOM representatives as per General Conditions of Contract.

After successful inspection, the inspecting officer shall ensure that all the offered transformers are complete and duly fitted with name, rating and diagram plate, identification plate (on tank body & Top cover) as specified in this specification.

NOTE:

1. INSULATION RESISTANCE MEASUREMENT:

Insulation resistance of selected samples shall be measured with a 2500V Megger, of standard make. The minimum insulation resistance shall be furnished by the supplier.

2. AIR PRESSURE TEST:

This test shall be conducted as type test at the time of inspection of first lot, at the manufacturer's works. The pressure gauge and vacuum gauge shall be duly calibrated and sealed by an independent recognised test lab(s).

The test procedure shall be as detailed below:

The tank shall be fixed with a dummy cover with all fittings including bushings in position and shall be subjected to air pressure of 0.8 Kg/cm^2 (gauge pressure), for 30 minutes. Permanent deflection of flat plate, after pressure has been released, shall not exceed specified value.

3. MAGNETIC BALANCE TEST:

This test shall be conducted as an additional test on one sample transformer from each lot offered for inspection.

4. OIL LEAKAGE TEST:

The oil leakage test shall be conducted on one unit selected from the offered lot of each rating. Transformer complete in all respects shall be subjected to the pressure corresponding to 0.5 Kg/ cm^2 and maintained for three hours. There should be no leakage at any point.

45. RANDOM SELECTION AND TESTING (RST):

a) For every lot of 200 transformers (or less) offered for factory inspection, the type tests mentioned at clause (40) should be mandatorily conducted by choosing a random sample from the lot. If the offered lot is between 200-500 Nos, at least 2 samples shall be type tested at CPRI Bangalore/ERDA. If the sample fails the Type test entire lot shall be rejected. The testing charges shall be borne by the supplier.

46. FAILURE IN TEST(S):

In the event of failure/ unsatisfactory results of the transformer(s) in any of the routine tests, acceptance tests or RST conducted on transformer, the supplier shall have to replace the supplies already made and no further transformers shall be accepted. The purchaser however, at his option, may accept the transformers already supplied with the following conditions:

a. Guarantee period of the supplied transformers issued to the field shall be increased by double the normal Guarantee period.

b. Bank Guarantee shall be extended to cover the additional Guarantee period.

c. For failure in any of the type tests listed under Clause (40), no further supplies shall be accepted.

d. The transformers lying in the store(s) shall be replaced as per sub para (v) below.

e. The supplier/manufacturer shall, however, be allowed to check the reasons of failure and if need be, to improve/ modify the design. Further supplies, including replacements against supplies already made, shall be accepted only after successful type test(s) are arranged on fresh transformer(s) selected by the authorized representative of the purchaser. All the type tests shall be arranged in case there is change in the design otherwise type test shall be repeated only for the test in which failure has occurred. Charges for such test(s) shall be borne by the supplier. However, in the event of failure of transformer in the repeat type test, the purchaser may take following actions:

a) Cancel pending orders of the rating in which failure(s) has occurred, &

b) Not place any order of Distribution Transformers on the firm for two to five year(s)/blacklisted from BESCOM.

47. MEASUREMENT OF TOTAL LOSSES (AT 50% & 100% LOADING):

i) After pre-dispatch inspection of material at firm's works, the dispatch instructions will be issued for the respective store(s) as per requirement of BESCOM. Sample(s) will be drawn from the lot(s) received in store(s) and will be subjected to the following test(s):

- One out of the every consignment of the transformers received at stores, above Routine Tests shall be conducted mandatorily (at Stores). In case of failure, all the transformers in that consignment shall be tested and transformers which pass the test shall be accepted.

ii) The percentage impedance voltage at rated current shall not exceed the permissible limit of 4.5% with plus or minus 10% tolerance failing which the sub lot of transformers represented by the sample shall be rejected.

iii) The application of low voltage to the middle limb will induce approximately equal voltages on the two end limbs. The application of voltage to the end limbs will induce greater voltage in the middle limb and less voltage in the other end limb. Uniformity of induced voltages shall confirm the healthiness of the transformer windings.

The procedure for the test shall be as under:

a) Apply 250 Volts between LV terminals-2u-2n and measure voltages between 2v-2n & 2w –2n.
b) Apply 250 Volts between 2v-2n and measure voltages between 2u-2n & 2w-2n.
c) Apply 250 Volts between 2w-2n and measure voltages between 2u-2n & 2v-2n.

The measured voltages shall satisfy the conditions detailed as above.

48. TOLERANCES:

Unless otherwise specified herein, the values of different parameters of the transformers supplied shall be within the tolerance permitted in the IS-1180 on the guaranteed values. Positive tolerance is not applicable for losses and negative tolerance not applicable for cross sections of winding specified.

49. FINISHING:

The exterior of the transformer tank and other ferrous fittings shall be thoroughly cleaned, scrapped/sand blasted and given a priming coat and two finishing coats of durable oil the weather resistance paints or enamel. The colour of finishing coats for transformers shall be as follows, as per IS:5

a) For 25 KVA	-	Sky Blue shade No. 101
b) For 63 KVA	-	Silver Grey shade No. 628
c) For 100 KVA	-	Brilliant green shade No. 221

50. TESTING OF TRANSFORMER OIL:

To ascertain the quality of the transformer oil, the original manufacturer's tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil, after taking out of the sample from the manufactured transformers and tested in the presence of purchaser's representative.

i. Guarantee:

The manufacturers of the transformer shall provide a guarantee of **5 years from the date of supply**. In case the distribution transformer fails within the guarantee period the purchaser will immediately inform the supplier who shall take back the failed distribution transformer within seven days from the date of the information at his own cost and replace/ repair the transformer within fifteen days of date of intimation with a roll over guarantee.

The outage period i.e., period from the date of failure till unit is repaired/ replaced shall not be countered for arriving at the guarantee period.

In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

b) Schedules:

The supplier shall fill in the following schedule which will be part of the offer. If the schedule are not submitted duly filled in with the offer, the offer shall be liable for rejection.

Schedule-A & A1 : Guaranteed Technical Particulars

c) Deviations:

The suppliers are not allowed to deviate from the principal requirements of the specifications.

d) Inspection:

To ensure about the quality of transformers, the inspection shall be carried out by the purchaser's representative at following two stages:

1. Online anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.
2. At finished stage i.e., transformers are fully assembled and are ready for despatch.

The stage inspection shall be carried out.

After the main raw-material i.e., core and coil material and tanks are arranged and transformers are taken for production on shop floor and a few assembly have been completed, the firm shall intimate the purchaser in this regard, so that an officer for carrying out such inspection could be deputed, as far as possible within seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled (only in case of CRGO material) to ensure that the CRGO laminations used are of good quality. Further, as and when the transformers are ready for despatch, an offer intimating about the readiness of transformers, for final inspection for carrying out tests as per relevant IS shall be sent by the firm along with Routine Test Certificates. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre- delivery inspection. The proforma for pre delivery inspection of distribution transformers is placed.

In case of any defect/defective workmanship observed at any stage by the purchaser's inspecting officer, the same shall be pointed out to the firm in writing for taking remedial measures. Further processing should only be done after Clarence from the inspecting officer/ purchaser.

All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacture and purchaser at the time of purchaser. the manufacture shall offer the inspector representing the purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include stage inspection during manufacturing stage as well as active part inspection during acceptance tests. The supplier shall give 10 days advance intimation to the purchaser to

organize stage inspection of the Transformer in which the assembly of core and the winding could be inspected. The BESCOM may at its option, open a transformer supplied to the stores, in the presence of the successful tenderer at site or at BESCOM stores. If any of the technical particulars are seen to be at variance with the guaranteed technical particulars the whole lot of transformers will be rejected and risk purchase resorted to.

51. INSPECTION AND TESTING OF TRANSFORMER OIL:

To ascertain the quality of the Transformer oil, the original manufacturer's test report should be submitted at the time of inspection. Also arrangements shall be made for testing of Transformer oil, after taking out the sample from the manufactured Transformer and tested in the presence of BESCOM's representative or in any independent laboratory viz., B.D.V. test should be conducted in presence of BESCOM representatives.

52. QUALITY ASSURANCE PLAN:

In respect of raw materials such as core stamping, winding, conductor, insulating paper and oil, the manufacturer shall use these materials manufactured/supplied by the standard manufacturers and furnish the manufacturers test certificates as well as the proof of purchase from these manufacturers (excise gate pass) for information of corporation.

The supplier shall invariably furnish following information along with his offer, failing which his offer, shall be liable for rejection.

Statement giving list of important raw materials including but not limited to:

a) Core material
b) Winding material
c) Insulation paper and press boards.
d) Transformer oil
e) Bushings
f) Tanks, conservator and radiators

Names of sub supplier for the raw materials, List of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Supplier's representatives, copies of test certificates.

1. Information and copies of test certificates as in (1) above in respect of bought out accessories.
2. List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of such tests and inspections.
3. Special features provided in the equipment to make it maintenance free.
4. List of testing equipment available with the supplier for final testing of transformers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. The limitations shall be very clearly brought out in the relevant schedule i.e., schedule of deviations from specified test requirements.

The supplier shall within 30 days of placement of order, submit following information to tile purchaser.

a) List of raw materials as well brought out accessories and the names of sub suppliers selected from those furnished along with offer.

b) Type test certificates of the raw material and bought out accessories.

c) Quality Assurance Plan (QAP) with hold points for purchaser's inspection. The quality assurance plans and hold points shall be discussed between the purchaser and supplier before the QAP is finalized.

The supplier shall submit the routine test certificate of bought out items and raw material, at the 6mm of routine testing of the fully assembled Transformer.

53. DOCUMENTATION:

All drawings shall conform to international standards organization (ISO) 'A' Series of drawing sheet/Indian standards specification IS:656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in SI Units.

The supplier shall furnish all the details of constructional feature showing tile details of all the items in the plan, sectional elevation and tile side elevation and indicate these details/dimensions.

The supplier shall furnish the magnetization characteristic curve for the core material of the transformer.

Two sets of the type test reports, duly approved by the BESCOM shall be submitted by the supplier for distribution before commencement of supply.

Supplier shall furnish the 2 Sets of drawings for approval.

The manufacture of the equipments shall be strictly in accordance with the approved drawings and no deviation shall be permitted without written approval of the company. All manufacturing and fabrication work in connection with the equipment prior to the approval of tile drawing shall be at tile suppliers risk.

Approval of drawings / work by BESCOM shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirement of the latest revision of applicable standards, rules and codes of practices. The equipments shall conform in all respects to high standards of engineering design workmanship and latest revisions of relevant standards at the time of supply and the BESCOM shall have the power to reject any work or materials which in his judgment is not in full accordance there with.

54. PACKING AND FORWARDING:

Each consignment shall be accompanied by a detailed packing list containing the following information.

a) Name of the Consignee.
b) Details of Consignment.
c) Destination.
d) Total weight of consignment
e) Signs showing upper / lower side of the crate.
f) Bill of Materials including contents of each package.

The monogram/name of the firm shall be blanked on the top cover of the Transformer.

55. PUNCH MARKING OF TRANSFORMER SERIAL NO:

The serial No. of the Transformer shall be punch marked on the transformers tank and also on the top cover in addition to that indicated on the name plate as per relevant clause.

56. Unique ID Code: Unique ID plate along with Unique ID code shall be provided.

57. COST ANALYSIS: The supplier shall furnish "Cost Analysis" sheets for each rating of Transformer.

(S.T. Shanthamallappa)
General Manager (El.)
Quality Standards and Safety,
BESCOM

SCHEDULE 'A'
GUARANTEED TECHNICAL PARTICULARS FOR DISTRIBUTION TRANSFORMER
(To be furnished by the manufacturer)

Sl No.	Description	
1.	Make	
2.	Name of Manufacture	
3.	Place of Manufacture	
4.	Voltage Ratio.	
5.	Rating in kVA.	
6.	Core Material used and Grade.	
	a). Flux density.	
	b). Over fluxing without saturation (Curve to be furnished by the manufacture in support of his claim).	
7.	Maximum temperature rise of:	
	a. windings by resistance method	
	b. Oil by thermometer	
8.	Magnetising (no-load) current at:	
	a. 90%	
	b. 100%	
	c.110%	
9.	Core loss in watts	
	a. Normal voltage	
	b. Maximum voltage.	
10.	Resistance of windings at 20°C (with 5% tolerance)	
	a. HV Windings (ohms).	
	b. LV Windings (ohms).	
11.	Full load losses (watt) at 75°C	
12.	Total Losses at 100% load at 75°C	
13.	Total Losses at 50% load at 75°C	
14.	Current density used for : (Amper/sqmm)	
	a. HV Winding	
	b. LV Winding	
15.	Clearances : mm	
	a. Core and LV	
	b. LV&HV	
	c. HV Phase to Phase	
	d. End insulation clearance to earth	
	e. Any point of winding to tank	
16.	Efficiency at 75°C	

	a. Unity P.F. and	
	b. 0.8 P.F.	
	1.125% load	
	2.100% load	
	3. 75% load	
	4. 50% load	
	5. 25% load	
17.	Regulation at:	
	a. Unity P.F. and	
	b. 0.8 P.F. at 75°C	
18.	% Impedance at 75°C	
19.	Flash Test:	
	(i) HV 28kV/50HZ for 1 minute	
	(ii) LV 3kV/50Hz for 1 minute	
20.	Over potential test (Double voltage and Double frequency for 1 minute)	
21.	Impulse test in peak kVA.	
22.	Mass of : (kg)	
	a. Core lamination (minimum)	
	b. Windings (minimum)	
	c. Tank and fittings	
	d. Oil	
	e. Oil quantity (minimum) (litre)	
	f. Total weight	
23.	Oil Data:	
	1. Qunatity for first filling (minimum) (litre)	
	2. Grade of oil used	
	3. Maker's name	
	4. BDV at the time of filling (kV)	
24.	Transformer:	
	1. Overall length x breadth x height (mm x mm x mm)	
	2. Tank length x breadth x height	
	3. Thickness of plates for	
	a. Side plate (min)	
	b. Top and bottom plate (min)	
	4. Conservator dimensions	
25.	Radiation:	
	1. Heat dissipation by tank walls excluding top and bottom	
	2. Heat dissipation by cooling tube	
	3. Diameter and thickness of cooling tube	
	4. whether calculation sheet for selecting cooling area to ensure that the transformer is capable	

	of giving continuous rated output without exceeding temperature rise is enclosed	
26.	Inter layer insulation provided in design for:	
	1. top and bottom layer	
	2. In between all layer	
	3. Details of end insulation	
	4. Whether wedges are provided at 50% turns of the HV coil	
27.	Insulation materials provided	
	a. For conductors	
	1. HV	
	2. LV	
	b. For core	
28.	Material and size of the wire used	
	1. HV Dia (mm) SWG	
	2. LV a) Strip size	
	b) No. of conductors in parallel	
	c) Total area of cross section (sq.mm)	
29.	Whether the name plate gives all particulars as required in tender	
30.	Particulars of bushings HV/LV	
	1. Maker's name	
	2. Type IS:	
	3. Rating as per IS	
	4. Dry power frequency voltage withstand test	
	5. Wet power frequency voltage withstand test	
31.	Type of insulation used in	
	a. HV windings	
	b. LV windings	
32.	Type of insulation used on	
	a. Core bolts	
	b. core bolt washers	
	c. Core laminations	
33.	whether conservator is provided	
34.	whether breather is provided	
35.	Approximate overall dimensions	
	a. height	
	b. Breadth	
	c. Length	
36.	Weight of insulated conductor	
	a. HV	
	b. LV	
37.	a. Weight of core	

	b. Tolerance	
38.	a. weight of complete Transformer for transport	
39.	Period for which this design of transformer has been in commercial use	
40.	Reactance of windings at 75 ° C/ph a.HV b. LV	
41.	Resistance of rated current and frequency a. HV b.LV	
42.	Bushing charcteristics Normal power frequency with voltage stand voltage (kV) Dry(kV) Wet (kV) 11kV 28 28 0.433kV 3 3	
43.	Material of bushing rod and nuts	
44.	Date of commencement of production of distribution transformer at the factory of the supplier	

Signature & Seal of the supplier

SCHEDULE 'A1'
GUARANTEED TECHNICAL PARTICULARS FOR DISTRIBUTION TRANSFORMER

Sl.No.	Particulars	
1.	Tank	
	a. Wall thickness mm	
	b. Top/bottom plate thickness mm	
	c. Welding of plates	
	d. Side wall joints	
	e. General	
	i. Reinforcement for walls	
	ii. Limits for permanent deflection	
	iii. channel (bore) mm	
2.	Core (Magnetic circuit)	
	a. Top yoke (single sheet) Thickness mm	
	b. Channel liner	
	c. Core wrapper	
	d. Core clamping	
	e. Core dimensions	
	i. height (window)	
	ii. Core diameter	
	iii. Limp centre	
	f. No load current (% of FL current)	
	g. No load loss in watts	
	h. Core material	
	i. Core fixing bolt Ø mm	
	j. Tie rod insulation mm paper	
3.	Winding (Electrical circuit)	
	a. Conductor material	
	b. Conductor insulation	
	i. HV winding	
	ii. LV winding	
	c. Conductor size	
	i. HV winding mm2	
	ii. LV winding mm2	
4.	Phase barrier board (press board)	
	a. Spacer between HV & LV coils	
	b. Coil end insulation mm	
	c. coil packing screw	
	d. HV jumper & delta formation	
	e. LV jumper mm	

	f. HV termination (bushing)	
	g. LV termination (bushing)	
	h. Spacers	
	i. Load loss at 50% and 100% load in watts	
	j. Percentage of impedance 75° C	
	k. Neutral current at full load in %	
5.	a. Coil packing	
	b. Tapping lead Cu mm	
	c. Neutral current	
	d. Breather (Silica gel)	

Note:

The following shall be specifically confirmed:

1. Whether the offer conforms to the limits of impedance mentioned in the specification
2. Whether the offer conforms to the limits of temperature rise mentioned in the specification
3. Whether the losses of the transformers offered are within the limits specified
4. Whether the transformers offered is already type tested for the design and test reports enclosed.

Signature & Seal of the supplier

Annexure B

Procedure for assigning Unique ID code to Distribution Transformers:

Alpha Numeric code	**Numeric** 1	**Numeric** 2	**Numeric** 3&4	**Numeric** 5&6	**Numeric** 7,8,9&10
3 digit code assigned to manufacturer by BESCOM	Star Rating	capacity	Year of manufacture	Month of manufacture	Sl.No of the Transformer as assigned by the manufacturer
Example: Sl.No :XYZ 1315063456					
XYZ	1	3	15	06	3456

Unique ID code: XYZ 1315063456. XYZ denotes First three letters (initials of Manufacturer as approved/to be approved by BESCOM) 3 star rated 63kVA distribution Transformer manufactured in the month of June during the year 2015 with Sl.No.3456.

a) Alphanumeric codes (3 Digits)

Alphanumeric code(3 digit)	**Name of the Company**	**Remarks**
XYZ	---	3 digit alpha numeric code assigned to manufacturer by BESCOM

b) Details of the 10 Digit code.

Digit	**Digit codes**	**Description of the Digit Code**
1st Digit	0,1, 2 or 3	0- Conventional(Un starred)
		1 – BEE-3 Star
		2- BEE-4 Star
		3- BEE-5 Star
2nd Digit	1 to 9	1- 15 KVA Capacity
		2-25 KVA Capacity
		3- 63 KVA Capacity
		4- 100 KVA Capacity
		5- 250 KVA Capacity
		6- 300 KVA Capacity
		7 - 500 KVA Capacity
		8- 750 KVA Capacity
		9 -990/1000 KVA Capacity
3rd & 4th Digit	15 or 16 etc.,	Year of Manufacture that is 2015 or 2016 etc
5th & 6th Digit	01 to 12	Month of Manufacturing
		01-Jan, 02-Feb,03-March etc., up to 12-Dec
7th to 10th Digit	0001 to 9999	Sl. No. of the transformer